Letters to the Editor

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ON THERMAL CONDUCTIVITY OF ALUMINIUM AT LOW TEMPERATURES

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There are two mechanisms conducting the heat in a metal As in non-conductors there is transfer of heat by the lattice waves and in addition a transfer by the electrons The total heat conductivity is thus made up of two components K_g the lattice conduction, and K_e the electronic conduction The electronic heat resistance $W(=1/K_e)$ can be written as $W = W_0 + W_i$, where W_0 is the resistance due to impurity scattering and W_i is the resistance due to the scattering of the conduction electrons by the lattice waves and imperfections. W_0 is of the form β/T, and W_i, at temperatures below about $\theta/10$, is of the form αT^2

Thus neglecting the lattice conduction K_g in the case of pure metals, we have for total thermal resistance $W = \alpha T^2 + \beta/T$ A plot of WT against T^3 over a certain range of temperature should be a straight line with a slope α.

In case of experimental curve for Al drawn by Andrews and his coworkers (1951), it is seen that such plot has two linear sections instead of one having slopes $\alpha = 2\ 470\times10^{-5}$ cm Watt.$^{-1}$ °K^{-1} for the range of temperature 3 5°K to 12.5°K. and $\alpha = 6\ 00\times10^{-5}$ cm Watt^{-1} °K^{-1} for the range 2 to 4°K

This observed variation in slope is explained on how θ the Debye characteristic temperature changes with T Rosenberg (1957) and others have observed such variations in slope in case of Cd, Zn and Hg, etc.

Semi-analytic method has been used in the case of Al to study the temperature dependence of θ at low temperatures (Seitz and Turnbull, 1956). The values of θ in the region where it first departs from θ_0, and the value of θ at 0°K, are given by $\theta^3 = \theta_0^3[1-f'(s, t)\ (T/\theta_0)^2]$. The parameters s and t are determined from the values of elastic constants at 0°K and values of f' for *bcc* and *fcc* lattices are determined from tables (Seitz and Turnbull, 1956). Using the elastic constants at 0°K for Al, $c_{11} = 1.226$, $c_{12} = 0.708$, $c_{44} = 0.306$, the characteristic temperature in case of central forces plus electron gas model is given by $\theta = 426.6 - 0.0544\ T^2$.

From this expression, it is seen that the temperature region in which θ starts changing with temperature approximately corresponds to the region in which the value of slope, α changes But from the ratio of values of α it seems necessary, in addition to the study of variation in θ to consider lattice conductivity because of impurities in the specimen and scattering by boundaries, the dominant source of thermal resistance at very low temperature. The lattice component would cause the curve WT against T^3 to dip below (Handbuch der Physik XIV p. 247)

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